ABSTRACT

The aim is to give a brief account of how to image the periodontal tissues and to describe in detail the radiological features of periodontal disease. Periodontal examination remains incomplete without accurate radiographs, which play an important role in the assessment of periodontal disease. An overall assessment of periodontal tissues is made on the basis of both the clinical examination and radiographic findings. The radiographic features of healthy and diseased periodontal tissues are discussed.

Keywords: Bite-wing, Periodontics, Periapical, Periodontology, Radiology.

INTRODUCTION

Radiography plays a very important part in the diagnosis, study and treatment of periodontal disease but it has its own limitations as in the case of gross periodontal disease which may be present with no radiographic indication of abnormality.1 The proper approach to the diagnosis of periodontal disease is a clinical one with the use of radiographs either to support some clinical finding or to yield additional evidence when possible.1 This paper is directed to the role of conventional radiographic methods as they remain the most commonly used imaging methods in clinical dental practice.

CHOICE OF RADIOGRAPHS

The radiographic projections available to study periodontal tissues include periapical, bite-wing and panoramic. Periapical radiograph is the film of choice for the evaluation of periodontal disease. The paralleling technique is preferred for the demonstration of the anatomic features of periodontal disease.2 It provides for more accurate assessment of crestal bone height. Bisecting technique may appear to show more or less bone loss than actually present (Figs 1A and B).2

Vertical bite-wing radiographs can be used to examine reduced alveolar bone level even when bone loss has been considerable and are best used as a post treatment or follow-up film. Horizontal bite-wing radiograph cannot adequately visualize severe bone loss2 (Figs 2A and B) but they can best demonstrate proximal and secondary caries.

Panoramic radiograph has little diagnostic value in the identification of periodontal disease. It is useful as a general survey, but may not show precise details. A dental panoramic radiograph (DPR) of optimal quality may offer a dose advantage over large numbers of intraoral radiographs when there are concurrent problems for which radiography is indicated, e.g. symptomatic third molars, multiple existing crowns/heavily restored teeth and/or multiple endodontically treated teeth in a patient new to a practice. However, in view of the limitations in fine detail on DPRs, supplementary intraoral radiographs may be necessary for selected sites.3

Full-mouth surveys of paralleling periapical radiographs have been considered to be a ‘gold standard’ for periodontal diagnosis and treatment planning.4 However if a panoramic radiograph is readily available that radiograph may alone be sufficient,5 or a panoramic radiograph may be supplemented by selected intraoral radiographs which numbered less than four per patient to reach the ‘gold standard’.6 It has been shown that if seven periapical radiographs supplement a panoramic oral radiograph then the effective radiation dose exceeds that of a full-mouth series of periapicals,7 but if the number is less than four, then there is a reduction in radiation exposure and yet the ‘gold standard’ in terms of information can be achieved.

In the interpretation of the periodontal tissues, images of excellent quality are essential because of the fine detail that is required. Also, exposure factors should be reduced when using film-based techniques to avoid burn out of the interdental crestal bone.8

RADIOPHIC FEATURES OF HEALTHY ALVEOLAR BONE

In health, the lamina dura around the roots of the teeth appears as a dense radiopaque line.2 The normal healthy alveolar crest is located approximately 1.5 to 2 mm apical to the cementoenamel junctions (CEJ) of adjacent teeth. As the age advances, due to passive eruption, there are some radiographic evidences of increase in the distance between the CEJ and the alveolar crest. Radiographically it is impossible to determine precisely the normal position of the alveolar crest for any particular age.

In the anterior region, the alveolar crest appears sharp and pointed. In the lower incisor area, the sharp crests are
normally covered by dense bone which is actually a continuation of the lamina dura. The absence of cortex in this area nearly always indicates that disease is, or has been, present. In the posterior regions, the alveolar crest appears flat and smooth. They are sometimes covered with a thin layer of dense cortical bone, which may be seen as a thin white line. These bony cortices are more often absent, however, even in normal cases, and are usually noted only in young persons. Bicuspid and molar areas which show no cortex may be regarded as normal if the level and density of the crests are normal. Alveolar crests, when flat, meet with the lamina dura at the necks of the teeth, forming well-defined right angles. A rounding of these angles always indicates a pathologic process (Fig. 3).

The normal periodontal ligament space appears as a continuous thin radiolucent line on the mesial and distal aspects of the teeth between the roots and the lamina dura and is of uniform thickness. There are slight differences in thickness of the periodontal membranes in different persons, but there is uniformity within the same person except in the presence of disease.

**BENEFITS OF RADIOGRAPHS IN PERIODONTAL DISEASE**

Despite its limitations, periodontal examination is incomplete without accurate radiographs, which can show most bony changes in association with periodontal disease (Flow Chart 1).

**Early Radiographic Changes in Periodontitis**

Radiograph is not sensitive enough to detect the earliest signs of periodontal disease. Glickman listed the sequence of early radiographic changes that occur in periodontitis as crestal irregularities, triangulation and interseptal bone changes. The crest of the interdental bone becomes rough and irregular along with indistinctness and interruption in the continuity of the lamina dura seen along the mesial or distal aspect of the interdental alveolar crest (Fig. 4). Triangulation is the widening of periodontal membrane space along either mesial or distal aspect of the interdental crestal bone. The sides of the triangle are formed by lamina dura and the root and the base is toward the crown (Fig. 5). One of the earliest radiographic signs of periodontitis is the finger-like radiolucent projections extending from the crestal bone into the interdental alveolar bone (Fig. 6). These projections are result of a deeper extension of the inflammation from the connective tissue of the gingiva. They represent widened blood vessel channels within the alveolar bone that allow for the passage of inflammatory fluid and cells into the bone.

**Evaluation of Bone Loss**

The radiograph actually indicates the amount of bone remaining and the amount of bone loss attributed to periodontal disease can be estimated indirectly as the difference between the physiologic bone level and the height of remaining bone (Fig. 7). Bone loss can be determined in terms of distribution, pattern and severity. When the bone loss occurs in isolated areas, with less than 30% of the sites involved, it is described as localized bone loss. When the bone loss is evenly distributed throughout the dental arches, with more than 30% of the sites involved, it is called generalized bone loss (Fig. 8). When the bone loss occurs on a plane that is at an angle to a line drawn from CEJ of a tooth to that of an adjacent tooth, it is called horizontal bone loss (Fig. 9). When the bone loss occurs on a plane that is parallel to a line drawn from CEJ of a tooth to that of an adjacent tooth, it is called vertical or angular bone loss (Fig. 10). Bone loss viewed on a dental radiograph can be defined as slight bone loss (1 to 2 mm), moderate bone loss (3 or 4 mm) and severe bone loss (5 mm or greater).

**Furcation Involvement**

Extension of the periodontal pocket between the roots of multi rooted teeth is called furcation involvement. Radiographs can be helpful in locating furcation involvement; however, the furcation involvement will not be seen unless the bone resorption extends apically beyond the furcation. Mandibular molar furca is much more sharply defined (Fig. 11) than the maxillary molar furca where the palatal root is superimposed over the furca (Fig. 12). Widening of the PDL space at the apex of the interradicular bony crest of the furcation is strong evidence that the periodontal disease process involves the furcation. If sufficient bone loss has occurred on the lingual and buccal aspects of a mandibular molar furcation, the radiolucent image of the lesion becomes prominent.

**Predisposing Factors**

A number of predisposing factors or local irritants contribute to periodontal disease. Dental radiographs play a major role in the detection of local irritants, such as calculus and defective restorations. Calculus appears radiopaque on a dental radiograph often appearing as pointed or irregular radiopaque projections extending from the proximal root surfaces (Fig. 13). Calculus may also appear as ringlike radiopacity encircling the cervical portion of a tooth (Fig. 14), a nodular projection or a smooth radiopacity on a root surface. The diagnosis of absence or presence of calculus deposits should not be based on radiographic
Figs 1A and B: Periapical radiographs showing difference in crest level using different techniques (A) Paralleling (B) Bisecting the angle

Figs 2A and B: Interdental bone in (A) Horizontal, and (B) Vertical

Fig. 3: Junction of alveolar crest and lamina dura

Fig. 4: Crestal irregularities (arrow)

Fig. 5: Widening of periodontal ligament space near the crest of interdental vessel channels within the bone (triangulation)

Fig. 6: Widened blood vessel channels within the inter septal alveolar bone

Fig. 7: Evaluation of amount of bone loss

Fig. 8: Generalized bone loss

Fig. 9: Horizontal bone loss

Fig. 10: Vertical bone loss

Fig. 11: Furcation seen as radiolucency in a lower molar

Fig. 12: Furcation in maxillary molar superimposed by palatal root

Fig. 13: Calculus on proximal surfaces

Fig. 14: Calculus appears as ring-like radiopacity
Radiology in Periodontics

Flow Chart 1: Role of radiographs in periodontal disease at a glance

- Loss of lamina dura
- Widening of periodontal ligament space
- Bone loss
- Characteristics of bone loss
  - Vertical
  - Horizontal
  - Generalized
  - Localized
- Calculus
- Faulty restoration
- Caries
- Root resorption
- Hypercementosis
- Bone sclerosis
- Quantification of bone loss
  - Amount of bone loss
  - Furcation involvement
- Perio-endo lesion

Crown-Root Ratio

Tooth stability is influenced by the amount of leverage placed on the periodontium. The type of leverage is dependent on the amount of tooth that is within bone (clinical root) in relation to the amount of tooth not within bone (clinical crown). An increase in length of the clinical crown produces unfavorable leverage on the periodontium\textsuperscript{10} (Fig. 16).

Activity of the Destructive Process

The destructive process of periodontal disease can be evaluated by comparing standardized radiographs taken over regular intervals. When the interdental septal bone crest is rough and irregular and the alveolar bone below the crest is devoid of any suggestion of bone opacity, it is most likely that the resorptive process is active. Nutrient canals indicate active and even rapid bone resorption. If a smooth surface of the alveolar bone with condensation of remaining alveolar bone is seen in the presence of bone loss, a static destructive process or slowly destructive process is indicated\textsuperscript{10} (Fig. 17).

External root resorption is sometimes seen in conjunction with periodontal diseases. Its identification is important because of its implications for tooth prognosis.

Hypercementosis

A direct causal relationship with periodontal diseases is not proven, but hypercementosis is seen occasionally on teeth with bone loss. It may be a response to inflammation or to the increased occlusal loading on a tooth with attachment loss.\textsuperscript{3} Hypercementosis appears as a bulbous enlargement of the root, most commonly seen in relation to the apical half of the root.

Prognosis

Prognosis based on radiographic information is considered good if the destructive process is not generalized, only a limited amount of bone has been lost, corrective etiologic
factors can be identified, the patient’s general health is good and more importantly the patient is motivated to save the remaining teeth and is capable of performing all routine and specialized home-care procedures as dictated by the extent and distribution of the periodontal disease.

LIMITATIONS OF THE RADIOGRAPH

Radiographs may provide an incomplete presentation of the status of the periodontium. Some of the important limitations of radiographs are:

- The condition of gingiva cannot be predicted from the radiographic appearance of alveolar crest
- Radiographs provide two-dimensional views of three dimensional situations. They often fail to disclose osseous destruction particularly that confined to the buccal or lingual surfaces of teeth
- Radiographs typically show less severe bone destruction than is actually present
- Measure of bone level from the CEJ is not valid when there is over eruption or severe attrition with passive eruption.
- Radiographs do not demonstrate the soft tissue to hard tissue relationship and thus provide no information about the depth of soft tissue pockets. However, if a radiopaque material, such as gutta-percha is inserted into the pocket, the base of the pocket can usually be recorded on the radiograph
- Widening of PL space on radiograph does not necessarily indicate tooth mobility (Fig. 18)
- They do not specifically distinguish between the successfully treated cases and the untreated cases.

CHRONIC PERIODONTITIS

Both localized and generalized chronic periodontitis are characterized by pocket formation and/or gingival recession, both clinically detectable without radiographs. Chronic periodontitis can be divided into localized, if less than 30% of available sites display clinical attachment loss, and generalized if more than 30% of sites display clinical attachment loss. This differentiation is made on the basis of clinical findings and so radiographs are not required, although radiographs may be used. In some clinical situations restorations may impede the accessibility of the periodontal probe into a pocket and/or may obscure the CEJ and so compromise the clinical assessment of the presence and severity of chronic periodontitis. In such a situation radiographic evidence of alveolar bone loss may be helpful. Similarly, subgingival calculus or root surface topographies or malformations may impede the passage of the periodontal probe. In these situations radiographic evidence of alveolar bone loss may be helpful as it may direct the attention of the examining clinician to probe carefully sites or teeth with evident radiographic bone loss.

AGGRESSIVE PERIODONTITIS

Aggressive periodontitis refers to periodontal disease of an aggressive and rapid nature that usually occurs in patients below 30 years. Its cause is not known; however, specific bacterial pathogens like Actinobacillus actinomycetemcomitans, functional defects of polymorphonuclear leukocytes, exuberant immune responses and inheritable factors have been implicated. Aggressive periodontitis is subclassified into localized and generalized.

Localized aggressive periodontitis is associated with attachment loss involving the incisors and first molars. In this form, the amount of bone loss correlates with the time of tooth eruption, in that the teeth that erupt first (incisors and first molars) have the most bone loss. This disease usually commences around puberty and the bone loss is rapid. Of interest is the fact that there are usually very few signs of soft tissue inflammation or plaque accumulation despite the presence of deep bony pockets. Often the patient will present with drifting and mobile incisors and early loss of first molars. The radiographic appearance of the bone loss in localized aggressive periodontitis typically consists of deep vertical defects. Maxillary teeth are involved slightly more and a strong left-right symmetry is common.

Generalized aggressive periodontitis can involve a variable number of teeth, from the least three to all of the dentition, and by definition is not confined to the first molars and incisors. The rapid bone loss may be of the vertical or horizontal pattern.

PERIO-ENDO LESION

This entity that may present clinically in a variety of ways is incompletely understood. It refers to teeth (typically molars) that have concurrent clinical and radiological signs of disease of periodontal and pulpal origin (Fig. 19). It may arise as a result of infection in a necrotic pulp draining via the periodontal ligament (usually in the presence of existing periodontal disease), toxins from pulp reaching PL space via lateral or accessory canals, especially in the furcation region and the root perforation.

CONCLUSION

Dental radiographs play an integral role in the assessment of periodontal disease. Periodontal examination is incomplete without accurate radiographs. An overall assessment of the periodontal tissues is based on both the clinical examination and radiographic findings each complementing one another.
REFERENCES


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